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Helping Pines Earn More With Weed Control

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Coleman W. Dangerfield, Jr.

Extension Agricultural Economics

H. Lamar Merck

Extension Forest Resources

The University of Georgia

Cooperative Extension Service

In Cooperation with:

John W. Taylor, Jr., and Clair Redmond

USDA Forest Service
Southern Region
1720 Peachtree Road, NW
Atlanta, Georgia 30367-4102

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Coleman W. Dangerfield, Jr.
Extension Agricultural Economist

H. Lamar Merck
Extension Forester

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INTRODUCTION

History of Weed Control In Pines

Weed control was probably one of the first forestry practices of early people. As they changed from foraging to gathering, humans began to care for the wild plants that provided their food and fiber. Even before they learned other agricultural practices, they must have realized that weeds interfered with food plants. So, as agriculture developed they learned that weed control can increase yields, improve quality, and facilitate harvesting.

Early examples of weed control are most often associated with mechanical means. In pine tree management this usually includes some type of heavy equipment. The work is slow and often expensive, but has been the most dependable means available to control woody plants in pines. Weed control may also improve profits.

Attempts to find selective herbicides suitable for economical release of pines has been a difficult task. Although most herbicides presently used have only recently been developed, research began many years ago. Sodium arsenite, one of the first chemicals developed, was tried in the 1930's.

Herbaceous weed control in newly planted pines is the most recently developed use of herbicides. It has recently been shown that control of these weeds and woody competition in young pines affect future growth and volume. Selective herbicides affect only target plants such as herbaceous or woody species. They have shown potential for this purpose and have been tried in the last 10 years.

SITUATION

Importance of Pines

Forestry and the forest industry provide significant income to the South, adding several billion dollars annually to the economy and employing several hundred thousand workers. Pine trees account for the majority of this value.

Supply and Demand for Wood

Studies indicate that demand for pine timber will increase faster than pine supply. This trend will maintain or increase stumpage prices well into the 21st century. To maintain a healthy forest economy, however, we must develop an adequate supply of timber. Fortunately, many opportunities to increase the timber inventory can also be profitable investments for landowners. For example, returns from planting pines on marginal or highly erodible lands can exceed inflation by 10 percent or more.

Importance of Chemical Weed Control

Regeneration and forest management investments can often be assured or made more profitable by vegetation management. Herbaceous weed control in newly planted pines can help assure survival and increase pine growth. Woody competition control is usually necessary before planting pines on cutover sites. On sites where less intensive or no site preparation is done before planting, release of pines from woody competition can increase growth several times over.

USING THE TABLES

The tables in this bulletin are designed to help you determine how much you can afford to spend on weed control in pine plantations. Tables 1 to 6 show the maximum dollars available to control weed competition under different production situations and different levels of competition. Tables 1 to 3 are for oldfield loblolly pine plantations. Tables 4 to 6 are for loblolly pine plantations planted on cut over sites.

Figure 1 pertains to several kinds of major soils: North (Mountains, Appalachian Valley and Ridge), Piedmont, and the Southern Coastal Plain and Atlantic Coast Flatwoods of Georgia. Similar situations occur in other southern states.

The dollar amounts used in this bulletin are in present-value terms. See appendix 2 for a brief explanation of what present value means. The 8- percentage nominal discount rate represents a 3 percent general inflation plus a 5 percent real return on the investment.

Herbaceous Weed Example:

Assume you need to know how much you could afford to spend to control herbaceous weeds. Your investment will be in an oldfield loblolly pine plantation during the first year of the rotation. For our example, assume your land is in the Coastal Plain and has an average site index of 80/60. (This means that the height of the dominant trees will be 80 feet when the trees are 50 years old, or 60 feet when the trees are 25 years old.

You plan on growing a 25-year rotation of trees. Your field has a severe weed problem. (Check appendix 1 to see the other production assumptions made for this herbaceous weed competition example.

Now, go to table 3 and look at the middle row under site index for "80/60" and 25 year-rotation. Go across to the right hand column under "severe." The answer is that weed competition would cost you about $80 per acre, in today's dollars (present value). If you do nothing to control weed competition in this field, you could

expect to lose $80 worth (present value) of wood growth over the 25-year rotation. Wood loss results from a combination of seedling deaths and slower tree growth. Thus, your goal would be to control the severe weed competition for less than the value of wood lost.For example, if you can control the weeds for $30 per acre, you could expect to increase the present value of your production by $80 per acre. Your increase profits, above doing nothing, would be $80 - $30 = $50 per acre. The maximum amount that you could expect to spend controlling a severe level of weed competition would still be $80 in this example.

Look at tables 1 to 3 and notice the trends. Money can be most profitably spent for herbaceous weed control in region 3 (Coastal Plains and Atlantic Coast Flatwoods), then region 2 (Piedmont), and least in region 1 (North). This is because wood product prices are higher in region 3. Although our example pertains to actual market conditions in Georgia, similar differences in regional markets occur in other States. Also, notice that more money can be spent to control weeds on higher site-index land and where longer rotations are grown.

Table 1. Maximum dollars per acre for weed control in year one in oldfield loblolly pine plantations, by site index, year of harvest, and level of herbaceous weed competition, north Georgia, 1988 (8.0% discount rate).

Site index [1]	Year [2]	Level of weed competition: Light	Moderate	Severe
68/50	20	$4.04	$4.54	$ 8.07
	25	5.89	6.65	11.77
	30	9.13	10.28	18.27
80/60	20	8.63	10.00	17.24
	25	13.00	14.68	26.01
	30	19.87	22.35	39.73
93/70	20	14.57	16.39	29.14
	25	23.63	26.59	46.27
	30	34.05	38.31	68.10

[1] Height of dominant trees, 50 to 25-year basis.
[2] Length of tree rotation in years

Table 2. Maximum dollars per acre for weed control in year one, in oldfield loblolly pine plantations, by site index, year of harvest and level of herbaceous weed competition, Peidmont Georgia. 1988 (8% discount rate).

Site index [1]	Year [2]	Level of weed competition: Light	Moderate	Severe
68/50	20	$ 9.02	$10.16	$ 18.07
	25	14.23	16.02	28.47
	30	20.76	23.37	41.54
80/60	20	19.64	19.64	34.90
	25	26.95	30.31	53.88
	30	36.58	41.16	73.17
93/70	20	29.01	32.64	58.02
	25	43.28	48.68	86.55
	30	55.30	62.22	110.61

[1] Height of dominant trees, 50 to 25-year basis.
[2] Length of tree rotation in years.

Table 3. Maximum dollars per acre for weed control in year one, in oldfield loblolly pine plantations, by site index, year of harvest, and level of herbaceous weed competition, Coastal Plain and Atlantic Coast Flatwoods, Georgia, 1988 (8% discount rate).

Site index [1]	Year [2]	Level of weed competition: Light	Moderate	Severe
68/50	20	$15.90	$17.89	$ 31.81
	25	22.94	25.80	45.87
	30	31.03	34.92	62.07
80/60	20	27.81	31.36	55.75
	25	39.99	44.98	79.97
	30	49.69	55.90	99.38
93/70	20	43.68	49.13	87.35
	25	61.06	68.69	122.12
	30	74.12	83.38	148.23

[1] Height of dominant trees, 50 to 25 year basis.
[2] Length of tree rotation in years.

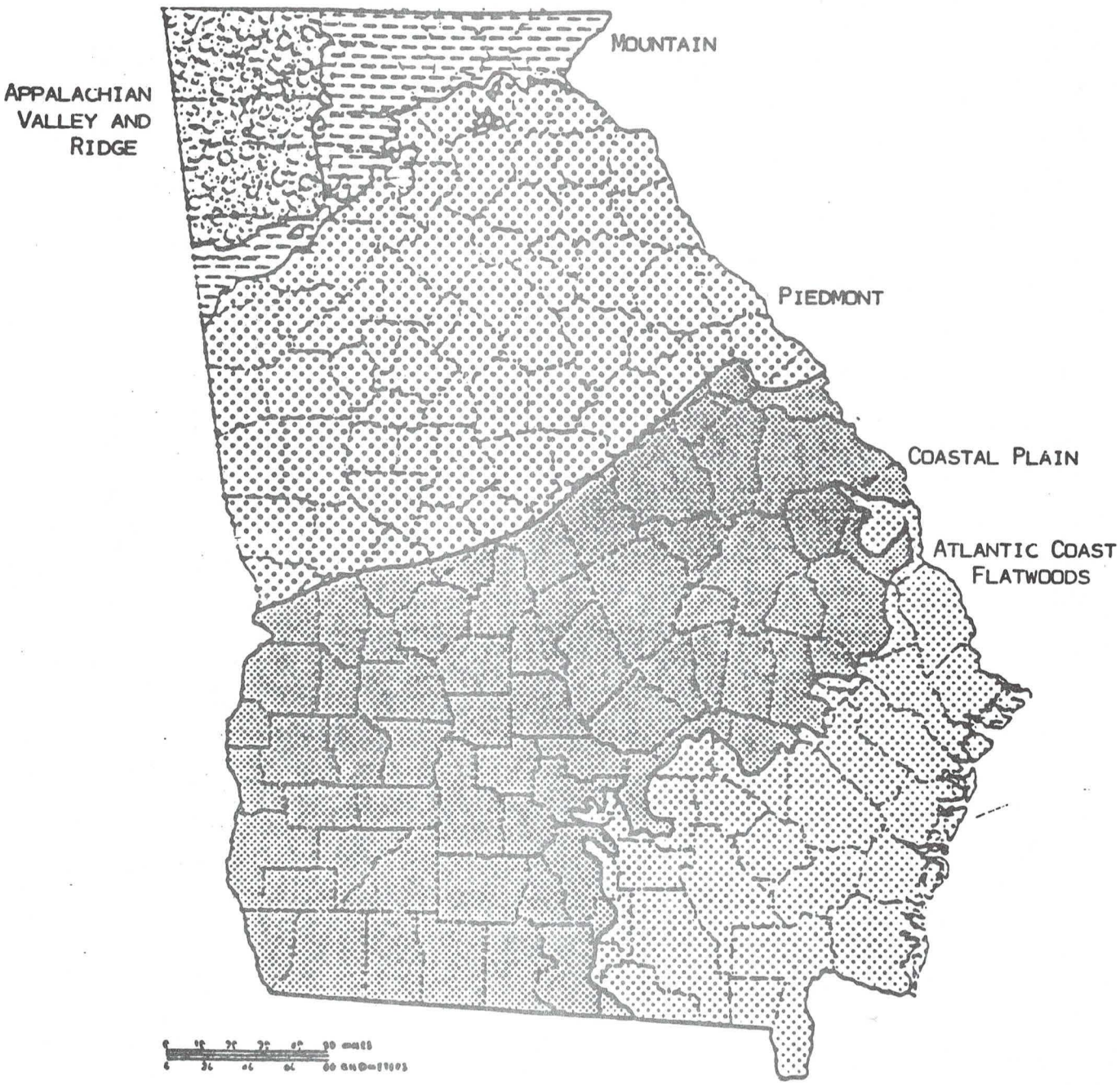

FIGURE 1. MAJOR SOILS PROVINCES OF GEORGIA REPRESENTATIVE OF CONDITIONS IN DIFFERENT PARTS OF MOST STATES IN THE SOUTHEAST

Woody Weed Example: Assume in this example that your property is in the Piedmont area of Georgia. You have a site from which all trees have been harvested (cutover site), and you want to replant a loblolly pine plantation. Assume that your land has a high site index of 93/70 and you want to grow trees for a 20-year rotation.

Also, you figure the hardwood basal area will be about 40 percent in your new pine plantation. This means that as the planted pines and hardwood sprouts grow together, in the new stand, pines will be 60 percent of the growth and hardwood competition will be 40 percent. You can see that competing hardwoods will rob you of pine tree growth and profits. (Check appendix 1 to see the other production assumptions made for this hardwood competition example.)

Your job is to calculate approximately how much you can afford to spend to control the competing hardwoods in your cutover loblolly pine plantation during its first few years of growth. Hardwoods should be controlled early in the rotation before pine growth is reduced later. Now, go to table 5 and look down the column under site index for 93/70 and 20-year rotation; check the column under 40 percent. The answer is that this level of hardwood competition will likely be costing you $127 worth of lost tree growth if you do nothing. The hardwoods should be controlled for $127 per acre, or less. For each dollar less than $127 that you spend to control the hardwoods, you will earn an extra dollar of profit over doing nothing.

Look at tables 4 to 6 and notice the trends. Money can most profitably be spent for woody weed control in region 3 (Coastal Plains and Atlantic Coast Flatwoods; then region 2 (Piedmont); and least in region 1 (North). This is because wood product prices are higher in south Georgia. Also, notice that more money can be spent to control weeds on higher site-index land and where longer rotations are grown.

Table 4. Maximum dollar per acre for weed control in year one, in cutover site loblolly pine plantations, by site index, year of harvest and level of woody weed competition, north Georgia, 1988 (8.0% discount rate).

Site index [1]	Year[2]	Level of weed competition 20%	40%	60%
68/50	20	$22.66	$ 26.35	$ 45.09
	25	32.47	34.47	56.05
	30	46.01	53.30	75.81
80/60	20	36.27	35.80	60.82
	25	56.22	55.87	88.04
	30	91.82	104.37	139.97
93/70	20	55.45	55.59	89.81
	25	125.59	78.28	123.11
	30	192.61	163.09	210.89

[1] Height of dominant trees, 50 to 25 year basis.
[2] Length of tree rotation in years.

Table 5. Maximum dollars per acre for weed control in year one, in cutover site loblolly pine plantations, by site index, year of harvest and level of woody weed competition, Piedmont, Georgia, 1988 (8.0% discount rate).

Site index[1]	Year[2]	Level of weed competition 20%	40%	60%
68/50	20	$ 32.00	$ 42.64	$ 70.53
	25	93.73	75.74	109.27
	30	87.64	87.83	128.10
80/60	20	51.34	67.91	105.25
	25	142.50	143.90	197.99
	30	148.97	152.77	219.34
93/70	20	65.74	127.03	179.57
	25	210.34	210.34	292.33
	30	255.65	219.38	312.50

[1] Height of dominant tree, 50 to 25 year basis.
[2] Length of tree rotation in years.

Table 6. Maximum dollars per acre for weed control in year one, in cutover loblolly pine plantations, by site index. year of harvest and level of woody weed competition, Coastal Plain and Atlantic Coast Flatwoods, Georgia, 1988 (8.0 % discount rate).

Site index[1]	Year[2]	Level of weed competition 20%	40%	60%
68/60	20	$ 55.87	$ 55.87	$ 97.71
	25	125.14	105.65	155.83
	30	119.60	122.82	181.21
80/60	20	139.80	97.30	153.15
	25	188.40	193.96	273.15
	30	195.56	205.40	300.08
93/70	20	98.42	176.70	254.99
	25	269.80	279.50	397.67
	30	320.99	283.93	414.47

[1] Height of dominant trees, 50 to 25 year basis.
[2] Length of tree rotation in years.

CONCLUSIONS

Control of herbaceous and woody weeds in loblolly pine plantations can increase profits. These higher returns come from improved seedling survival and increased tree growth. There is, however, a limit to the growth response that trees will make when weed competition is removed. Let's first discuss the economics of herbaceous weed control on oldfield sites. Then we can go over woody weed economics in cutover sites.

Herbaceous Weeds: Most of the damage done by grass and broadleaf weeds in planted pines is done in the first year of the pine rotation. After that, trees are generally above the weeds and better able to compete for growing space. Therefore, these weeds should be controlled early. Tables 1 to 3 show that the amount of money that can be profitably spent for herbaceous weed control varies according to conditions. Match your particular conditions to table, row, and column that most nearly apply to you. Remember, the object is to control the weed problem for less money than listed in the table. Then, your profits will increase to equal the difference between the table amount and the amount you spend on weed control.

Also, note that herbaceous weeds do not generally cause as much economic loss as woody weed competition in planted pines. This means that generally you cannot afford to spend as much money per acre controlling herbaceous weeds as on woody weeds. An exception is where herbaceous weed control is needed to ensure seedling survival.

Hardwood Weeds: Most growth loss in planted pines is caused by competing hardwoods. Competition between pines and hardwoods usually becomes more evident somewhere between years 10 and 15 in the rotation.

Economic damage, however, actually begins much earlier. Also, if hardwoods are controlled during the first couple of years of pine growth, the job is easier and less expensive.

As with herbaceous weed control, note from tables 4 to 6 that the amount of money that can be profitably spent for woody weed control varies greatly according to conditions. Match your particular conditions to the table, row, and column that most nearly apply to you. Remember, the object is to control the weed problem for less money than is listed in the table. Then your profits will increase to equal the difference between the table amount and the amount you spend on weed control.

Also, note that woody weeds generally cause much greater economic losses per acre than herbaceous weed competition in planted pines. This means that you can generally afford to spend more money per acre controlling woody weeds than you can controlling herbaceous weeds.

Appendix 1. Tree Production and Weed Competition

ASSUMPTIONS

This section clarifies how the trees discussed in this bulletin were grown and how weed competition was measured.

1. Tree species: Loblolly pine is used under two situations--oldfield and cutover site plantations, 650 trees per acre, at the end of the first growing season.

2. Land productivity: Low, medium, and high-productivity land was simulated by site indexes of 68/50, 80/60 and 93/70 feet at 50 and 25 years, respectively.

3. Cutting cycle: For the 20- and 25-year rotations, thinnings were done at 15 years. Even-aged thinnings were at 15 and 22 years for the 30-year rotation. Residual basal areas of 70, 80, and 90 square feet, per acre were left after thinnings for the low-, medium-, and high-productivity sites, respectively.

4. Prices were different in the three regions of the State (Prices were assumed to increase equal to the general inflation rate of 3 percent).

	Region 1 North	Region 2 Piedmont	Region 3 Coastal
Products	$ DBH[1]	$ DBH	$ DBH
Pulpwood (cord)	10.75 5-11	16.00 5-9	24.00 5-9
Chip-N-Saw (cord	----------	40.00 10-12	52.50 10-12
Sawtimber (MBF[2])	150.00 12-17	160.00 13-19	170.00 13-19
Big Sawtimber (MBF)	156.00 18-36	175.00 20-36	185.00 20-36

[1] Diameter Breast Height.
[2] Thousand Board Feet, Scribner.

5. Taxes, inflation and other costs: Provisions of The 1986 Tax Reform Act were incorporated into the tax effects.

° Marginal tax rate was 28 percent (for an average investor).

° No capital gains treatment, 84-month amortization and 10 percent investment credit on reforestation costs (you can charge off up to $10,000 in reforestation costs over an 8-year period).

° A nominal discount rate of 8-percent before taxes was used (8 percent is the assumed long run opportunity cost of using capital; that is, 3 percent general inflation plus 5 percent real return).

° Planting cost were $50 per acre for oldfield and $150 for cutover sites (including seedlings and planting expenses).

° Property taxes were excluded.

° A management expense of $2 per year was charged and inflated at 3 percent (the general inflation rate).

° A control burn was started at year 14, repeated every 3 years, for $5 per acre, and inflated as 3 percent.

6. Computer analysis was done using personal computer programs by Hepp, Hafley, and Burkhart.

7. Pine growth loss to herbaceous weed competition was calculated as follows: Light competition was expected to increase rotation length 2 years; medium 4 years; and severe 6 years. Treatment reduced light weed competition to none. With treatments, medium and severe competition were reduced to light pressure. This adjustment was adopted because weed control is not 100 percent effective.

8. Pine growth loss to woody weed competition was calculated from research findings by Burkhart and Sprinz (1984). A 20 percent basal area (BA) reduced pine production by 30 percent; 40 percent hardwood (BA) by 64 percent; and 60 percent hardwood BA by 88 percent. The 40 and 60 percent hardwood BA were reduced to 20 percent hardwood BA. This adjustment was adopted because weed control is not 100 percent effective.

Appendix 2. Value of Investment in Trees

NET PRESENT VALUE

Net present value (NPV) is one commonly used investment analysis where the value of cash-flows across time is important. NPV is the present value of expected future returns minus the present value of expected future costs. Costs and returns are discounted at the appropriate interest rate (Gunter 1984). The cash flows (costs and incomes) that occur through time are recalculated and expressed in today's dollars. With zero taxes, the present value of an investment is the maximum amount a firm could pay for the investment without being financially worse off.

The NPV method can compare mutually exclusive alternatives over different times. This can be accomplished by assuming that the investor will reinvest in assets of exactly the same characteristics as those being proposed for each alternative. This allows comparisons between mutually exclusive investment alternatives over different time periods. The formula used to calculate net present values in our examples is as follows:

$$NPV = \sum \frac{Rm}{(1 + I)M} - \sum \frac{Cm}{(1 + I)M}$$

Where Rm = a revenue item in year m
Cm = a cost item in year m
i = interest rate

Appendix tables 7 to 12 show the net present values of the forestry investment made for Tables 1 to 6. Some trends are evident here, and some additional explanation is needed.

First, a net present value of $0.00 means that the investment earned an interest rate equal to the discount rate (8 percent in our example). The 8 percent discount rate was selected to equal the return that we wanted to earn on our forestry investment. We assume here that 8 percent is the long run cost of using capital. We can allow 3 percent for inflation plus 5 percent that we want to earn on our forestry investment over inflation. This 3 percent inflation plus 5 percent above inflation equals the 8 percent discount rate chosen.

The 8 percent discount rate also says that if our forestry investment returns are projected to fall below 8 percent (IRR = 8 percent and NPV = $0) we have decided to invest our resources somewhere besides growing trees. We would do this because we think (in our example) that we can earn at least 8 percent by putting our resources in another investment.

A net present value less than $0.00 means that we earned less than 8 percent with that example. And, a new present value greater than $0.00 means that we earned more than 8 percent on that example. The higher the NPV, the more profitable is that example.

Tables 7 to 12 show a wide range in the net present values calculated from all the different examples. These values let you locate where your case would best fit. From them you can see what the net present value of your forestry investment would likely be.

Now, look at the trends. As with tables 1 to 6, net present values are generally higher in south Georgia, the area has higher site indexes and longer tree

rotations. Additionally, growing pine trees is relatively more profitable nearer the coast where most of the wood markets are located. Also, higher site indexes (more productive land) and longer rotations (larger sawtimber trees earn higher incomes.

Table 7. Net present value, in dollars per acre, of oldfield loblolly pine plantations, by site index, year of harvest, and level of herbaceous weed competition, north Georgia, 1988, (8.0% discount rate).

Site index [1]	Year[2]	Level of weed competition: None	Light	Moderate	Severe
68/50	20	$50.46	$46.42	$ 41.88	$ 38.35
	25	73.60	67.71	61.09	55.94
	30	14.17	105.04	94.76	86.77
80/60	20	07.81	99.18	89.48	81.94
	25	62.55	149.55	134.92	123.54
	30	48.97	228.45	206.10	188.72
93/70	20	82.13	167.56	151.17	138.41
	25	95.43	271.80	245.21	225.53
	30	25.64	391.59	353.28	323.49
		0%	8%	17%	24%
		Decrease from Present Value			

[1] Height of dominant trees, 50 to 25 year basis.
[2] Length of tree rotation in years.

Table 8. Net present value, in dollars per acre, of oldfield loblolly pine plantations, by site index, year of harvest, and level of herbaceous weed competition, Piedmont-Georgia, 1988 (8% discount rate).

Site index[1]	Year[2]	Level of weed competition: None	Light	Moderate	Severe
68/50	20	$112.91	$ 103.88	$ 93.72	$ 85.81
	25	177.93	163.70	147.68	135.23
	30	259.56	238.80	215.43	197.26
80/60	20	218.14	200.69	181.05	165.79
	25	336.81	309.86	279.55	255.98
	30	457.28	420.70	379.54	347.53
93/70	20	362.64	333.63	300.99	275.61
	25	540.95	497.67	448.99	411.12
	30	691.17	635.97	573.75	525.36
		0%	8%	17%	21%
		Decrease from Present Value			

[1] Height of dominant trees, 50 to 25 year basis.
[2] Length of tree rotation in years.

Table 9. Net present value, in dollars per acre, of oldfield loblolly pine plantations, by site index, year of harvest, and level of herbaceous weed competition, Coastal Plain and Atlantic Coast Flatwoods, Georgia, 1988 (8% discount rate).

Site index[1]	Year [2]	Level of weed competition: None	Light	Moderate	Severe
68/50	20	$198.78	$182.88	$ 164.99	$151.07
	25	286.70	263.76	237.96	217.89
	30	387.92	356.89	321.97	294.82
80/60	20	348.42	320.55	289.19	264.80
	25	499.85	459.86	414.88	379.89
	30	621.11	571.42	515.52	472.04
93/70	20	545.94	502.26	453.13	414.91
	25	763.26	702.20	633.51	580.08
	30	926.47	852.35	768.97	704.12
		0%	8%	17%	24%
		Decrease from Present Value			

[1] Height of dominant trees, 50 to 25 year basis.
[2] Length of tree rotation in years.

Table 10. Net present value, in dollars per acre, of cutover site loblolly pine plantations, by site index, year of harvest, and level of woody weed competition, north Georgia, 1988 (8% discount rate).

Site index [1]	Year[2]	Level of weed competition 0%	20%	40%	60%
68/50	20	$-51.89	$-74.55	$-100.90	$-119.64
	25	-33.69	-66.14	-100.61	-122.19
	30	-05.79	-51.80	-105.10	-127.61
80/60	20	-16.09	-52.36	-88.16	-113.18
	25	25.57	-30.65	-86.52	-118.69
	30	107.83	16.01	-88.36	-123.96
93/70	20	33.90	-21.55	-77.14	-111.36
	25	133.98	8.39	-69.89	-114.72
	30	283.67	91.06	-72.03	-119.83
		0%	30%	64%	88%
		Decrease in Wood Flow			

[1] Height of dominant trees, 50 to 25 year basis.
[2] Length of tree rotation in years.

Table 11. Net present value, in dollars per acre, of cutover site loblolly pine plantations, by site index, year of harvest, and level of woody weed competition, Piedmont Georgia, 1988 (8.0% discount rate).

Site index [1]	Year [2]	Level of weed competition: 0%	20%	40%	60%
68/50	20	$-12.70	$-44.70	$-87.34	$ -115.23
	25	86.84	-6.89	-82.36	-116.16
	30	94.98	7.34	-80.49	-120.84
80/60	20	50.87	-0.47	-68.38	-105.62
	25	229.54	87.04	-56.86	-110.95
	30	253.74	04.77	-48.00	-114.57
93/70	20	142.48	76.74	-50.29	-102.83
	25	397.63	187.25	-23.09	-105.05
	30	460.32	204.67	-48.00	-107.83
		0%	30%	64%	88%
		Decrease in Wood Flow			

[1] Height of dominant trees, 50 to 25 year basis.
[2] Length of tree rotation in years.

Table 12. Net present value, in dollars per acre, of cutover site loblolly pine plantations, by site index, year of harvest, and level of woody weed competition, Coastal Plain and Atlantic Coast Flatwoods, Georgia, 1988 (8.0% discount rate.

Site index [1]	Year[2]	Level of weed competition 0%	20%	40%	60%
68/50	20	$44.75	$-10.82	$-66.69	$-108.53
	25	73.99	48.85	-56.80	-106.98
	30	90.27	70.67	-52.15	-110.54
80/60	20	198.85	$ 59.05	$-38.25	$ -94.10
	25	362.39	173.99	-19.91	-99.16
	30	394.25	198.69	-6.71	-101.39
93/70	20	263.49	165.07	-11.63	-89.92
	25	577.17	307.37	27.87	-90.30
	30	643.99	323.00	-39.07	-91.47
		0%	30%	64%	88%
		Decrease in Wood Flow			

[1] Height of dominant trees, 50 to 25 year basis.
[2] Length of tree rotation in years.

Appendix 3. Data and Calculations

Calculations in this bulletin are based on research showing pine growth loss due to herbaceous and woody weed competition. Loss in wood growth with different levels of weed competition is expressed as changes in net present values.

Research on the biological effects of herbaceous weed competition on pine growth is not as complete and documented as would be desirable (Bacon and Zedaker, 1987; Glover, et. al. The results from earlier research, however, have been extrapolated for use here. This is an effort to project beyond the range of values known with certainty to provide answers to current economic problems where no better answers exist. In that sense, table results for levels of herbaceous weed competition in oldfield loblolly pine plantations are presented as best estimates.

Research on the effects of woody weed competition on pine tree growth is well known and documented (Burkhart and Sprinz, 1984). Earlier research results were used in this bulletin to estimate reductions in wood growth under different levels of hardwood competition. These reductions were then calculated as changes in net present values.

REFERENCES

Bacon, Catherine G.; Zedaker, S. M. 1987. Third-year growth response of loblolly pine to eight levels of competition control. Southern Journal of Applied Forestry. 11(2): 91-95.

Barry, P. J.; Hopkins, J A.; Baker, C. B. 1983. Financial management in Agriculture. 3rd ed. Danville, IL: The Interstate Printers and Publishers, Inc.

Burkhart, H. E.; Sprinz, P. T. 1984. A model for assessing hardwood competition effects on yields of loblolly pine plantations. Publication No. FWS-3-84. Blacksburg, VA: Virginia Polytechnic Institute and State University, School of Forestry and Wildlife Resources. 61 p.

Glover, Glenn R.; Creighton, Jerre L.; Gjerstad, Dean H. 1989. Herbaceous weed control increases loblolly pine growth. Journal of Forestry. 87(2): 47-50.

Gunter, John E.; Haney, Harry L., Jr. 1984. Essentials of forestry investment analysis. Corvallis, OR: OSU Book Stores Inc.

Hafley, W. L. [n. d.] NCSU, Managed loblolly pine plantation growth and yield Simulator (Computer program available from author at Dept. of Forestry, North Carolina State University, P. O. Box 8002, Raleigh, NC 27695.)

Hepp, Todd E. 1982. YIELD: Timber yield forecasting and planning tool. Southern Journal of Applied Forestry. 6(3): 135-140.

NOTE: Our INFOSOUTH librarian found another, almost identical reference to the last item above. If the INFOSOUTH citation is preferable to the one above, insert it as follows: